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(54) Title: INTELLIGENT WIRELESS MULTICAST NETWORK
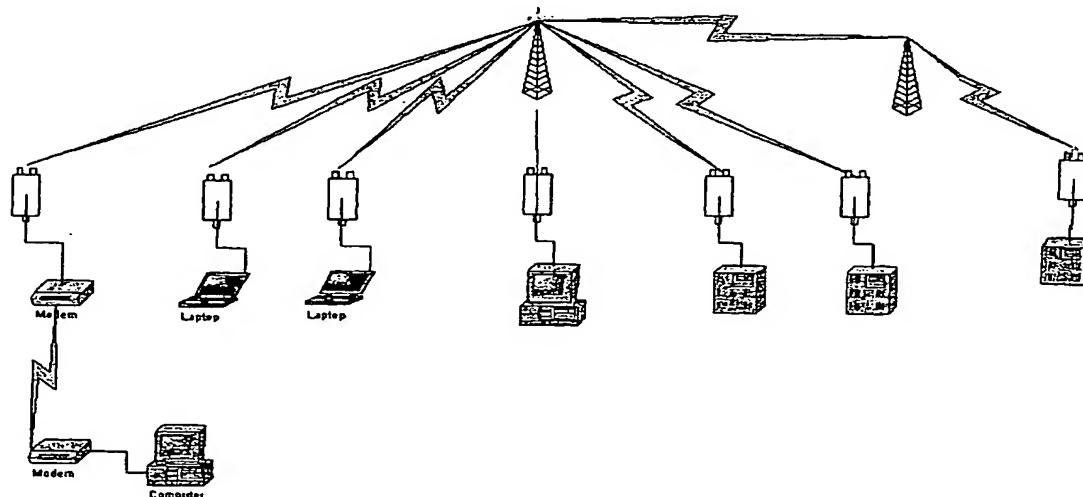
(57) Abstract: Disclosed is a supervisory control and data acquisition (SCADA) system using a spread spectrum or licensed frequency data radio network and communication method therefore allowing multiple slave hosts and slave devices or remote terminal unit (RTU) the ability to communicate data connectivity in a wireless network environment.

INTELLIGENT WIRELESS MULTICAST NETWORK

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a unique communication system that allows multiple mobile and stationary computers to communicate information, and mor specifically oil and gas field information with a remote supervisory control and data acquisition (SCADA) system in a wireless multicast network environment. More specifically it relates to an improved oil and gas field data communication methodology that affects improved oil and gas field operating efficiency.

2. Background of the Related Art

The majority of oil and gas fields cover a large geographic area and are often situated in remote and adverse terrain. Because of the communications protocol typically used and the limited historical memory of the SCADA system, the master computer system has to constantly scan the field. The constant scanning of remote SCADA units inherently ties up the radio system and disallows any other computer systems from scanning the SCADA units. The conventional (SCADA) supervisory control and data acquisition system uses the spread spectrum or licensed frequency data radio for a single host or for a single master system to scan the remote telemetry units (RTUs) or slave systems in the field to, for example, to retrieve measurement data from a remote telemetry unit and or to download a command from a master control unit to activate an element, i.e., to turn a valve off or on. For other computer systems to access field or RTU remote telemetry unit data, it must go through the master computer host outside of the radio network. This in turn requires a second computer networking system and software to allow another computer within the network to access the field or RTU's remote telemetry unit data. In the known prior art, U.S. Patent Publication 2003/0162538 appears to teach remote control units and a telemetry data reporting system that allows remote control from a remote communication center which sends out and receives transmissions. U.S. Patent 5,941,305 and 6,041,856 appear to teach a real-time data acquisition system using remote control units that report data variables such as temperature, pressure, flow characteristics *etc.* via radio link. U.S. Patent 4,721,158; 5,252,031; and, 5,819,849 appear to teach oil well pump control systems through monitoring by RTU's. U.S. Patents and Publications 2003/0174070; 2002/0198978; 3,803,362; 5,335,730; and, 5,010,333 appear to teach

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telemetry systems for remote monitoring of wells in which transmission links send well data to a remote monitoring system. None of these references teach or suggest ***

SUMMARY OF THE INVENTION

5   It is thus an object of the present invention to provide a machine method and system that is specifically designed to allow access to oil and gas field operating data and to control oil and gas field production from anywhere, using a communication system similar to a cell phone operating system.

       It is another object of the present invention to allow an operator to control and operate a

10   remote oil or gas well from anywhere in the field, as well as from any office or location using a conventional phone line.

       The present invention satisfies these objects and specifically overcomes the disadvantages of the prior art discussed above. Accordingly, the present invention is directed to a supervisory control and data acquisition (SCADA) system using an intelligent wireless

15   multicast network (IWMN) communication system that allows multiple slave host computers asynchronous communications to the slave computers remote telemetry units (RTUs).

       The object of the present invention is to allow multiple slave host computers access to any slave computer or remote telemetry units (RTU) on the same radio system as the

20   master host computer. One advantage is to allow field personal the ability to scan any (RTU) remote telemetry units in the field from his/her slave computer or (RTU) remote telemetry unit, for example from a vehicle. Real time and historical data can be stored in slave computer or (RTU) remote telemetry units and retrieved and transmitted.

       In order to achieve the above objective, every slave device either (RTU) remote telemetry

25   units or slave host has to link to one master host in the radio network. When a message is transmitted from a slave device, the master host computer will receive and handle the message. During the handling process, the host computer will parse through the message and first determine if the message is intended for the master host computer. If the message is not intended for the master host computer, the message is then re-broadcast or

30   re-transmitted out to all of the slave devices in the radio network. This echoing affect allows communication between slave devices in the radio network.

       The machine method in accordance with the present invention includes at least a "remote component system" and a "host component system". The remote component system is

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located at a wellhead location, the wellhead location usually being remote from a central

operations office at which the host component system is located. The remote component

system includes an art known electronic computer data logger, such as an electronic chart

recording system. The electronic data logger of the remote component system is

5   connected to transducers at oil and gas wells in the field that measure and transmit line

pressure, flow differential pressure, and temperature, all as analog data. In preferred

embodiments, as taught for example in Ocondi U.S. Patent 5,983,164, the remote

component system is also connected to transducers that measure and transmit the oil and

gas well data casing pressure and the pressure of the tubing immediately adjacent to the

10 well head, also as analog data. Also, as taught for example in Ocondi U.S. Patent

5,983,164, the remote component system electronic data logger includes software to trend

the analog data accurately, and a memory system to store in a retrievable format, as a

function of time, the analog data so collected. To maintain measurement integrity the

memory system also stores and logs digital data of precise events, such as valve positions,

15 to indicate the actual period of gas flow, all as a function of time. The remote component

system also includes a system for transmitting both analog trending and event log digital

data to the host component system, which is normally located at the central operations

office, upon request. In preferred embodiments, the analog trending and event log digital

data will be transmitted using art known data compression technique.

20 The third component of the system, as a part of the communication network scheme,

using an art known notebook computer connected to a FreeWave radio. FreeWave radios

are a non-licensed spread spectrum data radio. Currently, each FreeWave radio can

transmit data up to 115,000 BPS "Bits Per Second" (2X of a 56K phone modem). The

data is packetized and stamped with an address of the destination radio and a CRC value

25 to provide transmission error detection. Since the radio uses a non-licensed radio

frequency, there is a greater chance for emf interference. When the receiving radio

receives the data, it determines if the message contains the address of the receiving radio.

If the address matches the address of the receiving radio own, the data is then checked for

validity with the CRC value. If the entire data stream is verified, the data is passed to a

30 terminal device.

The FreeWave radio-to-radio data throughput is about 6 X of the data between the

devices. This allows several messages from different scanning devices to communicate

to the FreeWave radio at the same time. The Freewave radio has several built in

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functions that allow for data retries and   linking. Every FreeWave radio can be programmed to act as a repeater, node repeater "RTU Repeater", network, slave and master radio.

These and other objects of the present invention will become apparent to those skilled in the art from the following detailed description, showing the contemplated novel construction, combination, and elements as herein described, and more particularly defined by the appended claims, it being understood that changes in the precise embodiments to the herein disclosed invention are meant to be included as coming within the scope of the claims, except insofar as they may be precluded by the prior art.

BRIEF DESCRIPTION OF THE DRAWINGS:

The accompanying drawings illustrate complete preferred embodiments of the present invention according to the best modes presently devised for the practical application of the principles thereof, and in which:

FIG. 1 is a view illustrating the construction of a conventional wireless SCADA system;

FIG. 2 is a block diagram of a single SCADA supervisory control and data acquisition system with one master host and one slave computer and one (RTU) remote telemetry unit, all wirelessly linked through a single tower according to the present invention; and

FIG. 3 is a block diagram of a SCADA supervisory control and data acquisition system with one master host and several slave computers RTUs, all wirelessly linked through a single tower according to the present invention; and

FIGS. 4 illustrates a flowchart illustrating methods operating the SCADA supervisory control and data acquisition system with one master host and several slave computers RTUs according to the present invention as shown in FIGS. 2 and 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As used herein, a Remote Terminal Unit (RTU) is a computer with software and hardware that records and controls remote electronic devices measuring and controlling oil and gas fields. Such devices include, for example, those used for reading pressure and flow volumes in oil and gas wells and fields. Others such electronic devices are used to open and close valves in oil and gas wells and fields. The RTUs also record device information which, in the practice of the present invention, are transmitted to other computers to use. The RTU can also control external devices. The data stored in the RTU

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can be uploaded and downloaded from other computers known as host computers. Data transferred wirelessly is done through a radio network.

As used herein, a radio network is a system of data radio devices that are all connected wirelessly allowing data to be transferred between host computers and RTU computers.

5   In such a radio network the radios are configured for different purposes. There are slave radios and repeater radios ion the network. The slave radios and repeater radios are all linked to at least one master radio. Every message transmitted by a slave radio is received by the master radio. The repeater radio is used to expand the range of the master radio. The repeater radio just hops any message received by the master and or slave radio.

10   As used herein, a master host computer is a computer with software that has access "connectivity" to a data radio. The software in the master host computer will transfer data to and from any RTUs in the radio network through the data radio. There is normally only one master host computer in the radio network. All other computers in the radio network are known as slave devices or slave computers.

15   As used herein, a slave host computer is a computer with software that has access "connectivity" to a data radio. The software in the slave host computer will transfer data to and from one or more RTU in the radio network through the data radio. There can be multiple numbers of slave host computers.

In the practice of the present invention, every computer will have an assigned address that makes it unique in the network. All data messages transferred by any computer on the radio network, contains the address of the source computer and the destination computer. Referring to the flow charts of FIGS. 3 and 4, the present invention provides master host message handling and echoing messages back on the radio network. Messages from the master host computer are received by every slave device in the radio network. Only one slave device having an address that matches the intended destination address will store and process the intended message. Messages from any and all slave hosts in the field will first be received by the master host. Each received message will carry the address of the originating slave host and the address of the destination computer. The master host will attempt to identify that destination address in order to identify the originating slave host for that message. If the master host can identify the originating slave host for that message it stores and process the information received. If the master host cannot identify the originating slave host for any particular message, that is if the message is not intended for the master host, then the master host rebroadcasts the message to all of the slave

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devices so that the intended slave device   can receive stores and process the information received.

Software directs and manages the data flow within the network

Because of the power of the Freewave radios mentioned above, software has been

5   provided, for example as shown in the 37 pages of comm.text, enclosed with the priority claimed U.S. provisional application, to focus on controlling and directing the flow of data to allow multiple computers or host systems including field notebook units. Each RTU and Host device uses CRC for error checking on every packet of data. Every data message includes a source and destination address. When any device master or slave

10   sends a data message on the radio system, all devices on the radio network will receive the same message. The device with a matched destination address will respond.

Data managing software such as comm.text coupled with the addressing scheme provided by the internal software of the FreeWave radio, creates an intelligent data traffic manager that allow several host systems to communicate to any systems with in the network.

15   Since any radios within the network are capable of storing and forwarding operations, a virtual unbound communication system is created by the invented software system. Therefore, a remote computer host can reach any RTU site as long as it is within communication range with any other RTU site or a repeater site within the network. The following maps will show how the above communication scheme can be accomplished

20   using the invented software.

The present invention also utilizes software programs that operate iin conjunction with the multicast spread-spectrum peer to multipeer radio system. The software installed at the master host computer acts as a data traffic director. Every message transmitted contains a source and destination address. All messages transmitted from SCADA units

25   and mobile computer systems are received by the master host computer. The message received is decoded and interpreted. The destination address in the message is compared to the source address of the master host. If the message is not intended for the master host, it is encoded and retransmitted "echoed" to all SCADA and mobile units in the field. This methodology of interpreting and redirecting data is the source of the intelligent

30   wireless multicast network.

To accomplish the traffic director task, the system is designed to operate in a distributive mode whereby the host system only communicates with the remote SCADA systems during off "office hours". Historical data is stored in nonvolatile memory for a selected
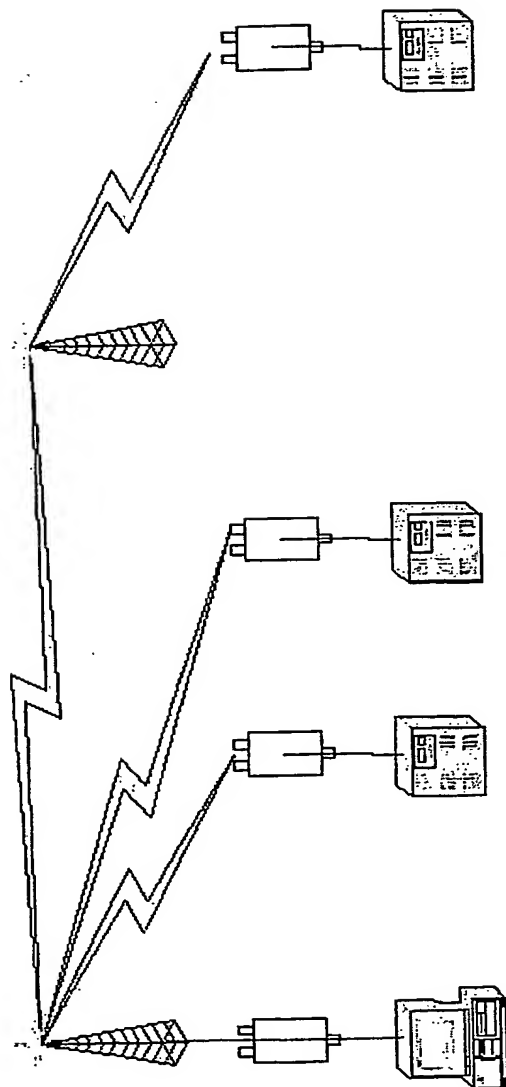
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period, say up to 35 days, at every SCADA unit. In conjunction with the protocol, data compression and high-speed throughput the master host can scan several days of historical data in a short period of time. This will allow the host to resume the traffic directing duty and free the airwave for the remote SCADA systems to initiate

5   transmission of critical alarm messages.

A conventional phone line can be used in conjunction with a dialup modem and spread spectrum radio to allow computer systems off site to access SCADA systems in the field. The foregoing exemplary descriptions and the illustrative preferred embodiments of the present invention have been explained in the drawings and described in detail, with

10   varying modifications and alternative embodiments being taught. While the invention has been so shown, described and illustrated, it should be understood by those skilled in the art that equivalent changes in form and detail may be made therein without departing from the true spirit and scope of the invention, and that the scope of the present invention is to be limited only to the claims except as precluded by the prior art. Moreover, the

15   invention as disclosed herein, may be suitably practiced in the absence of the specific elements which are disclosed herein.

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What is claimed is:

1. Wireless data communication systems, comprising:

    a master host computer for directing wireless data messages, performing remote control and measurement of remote terminal units (RTU)'s;

    a data radio communication network for connectivity between master and slave devices;

    multiple slave host computers for performing remote control and measurement of RTUs; and

    a dial-in phone modem and or cellular modem for connectivity of slave host computers outside of the data radio communication network.

2. The wireless data communication system as claimed in claim 1, master-host computer includes a spread spectrum or licensed frequency data radio; and a computer system.

3. The wireless data communication system as claimed in claim 1, wherein data radio communication network includes:

    a spread spectrum or licensed frequency data radio;

    one master radio connected to the master host computer to allow connectivity to all slave radios;

    one or more repeater radio to allow for expansion on the radio network; and

    slave radios connected to RTUs, slave host computers, cellular phone modems and dial-in phone modems.

4. The wireless data communication system as claimed in claim 1, multiple slave host computers includes:

    a spread spectrum or licensed frequency data radio; and

    a computer system.

5. A method of allowing multiple slave host computers on the same data radio communication network to communicate simultaneously, comprising the steps of:

    linking a master host computer to a radio communication network directing data messages on the network;

    receiving and repeating any data messages at a master host computer that are not intended for the master host computer from any slave host computer; and

    transmitting repeated messages from the master host computer are received by all slave radios in the radio network by the RTUs to thereby allow communications between multiple slave host computers and RTUs on the radio network.

6. All oil and gas field data communication systems and machine methods that affects improved oil and gas field operating efficiency as disclosed herein.
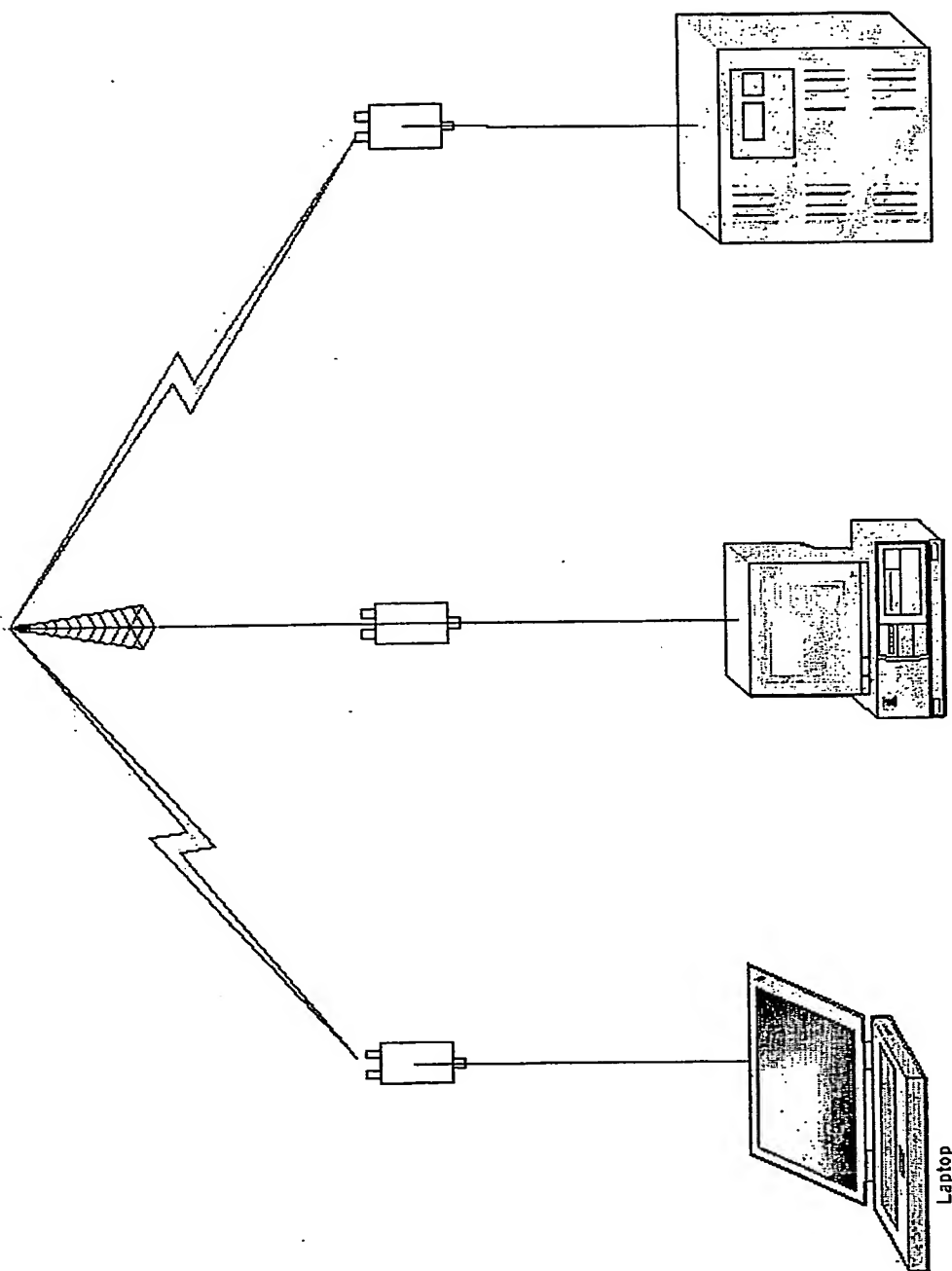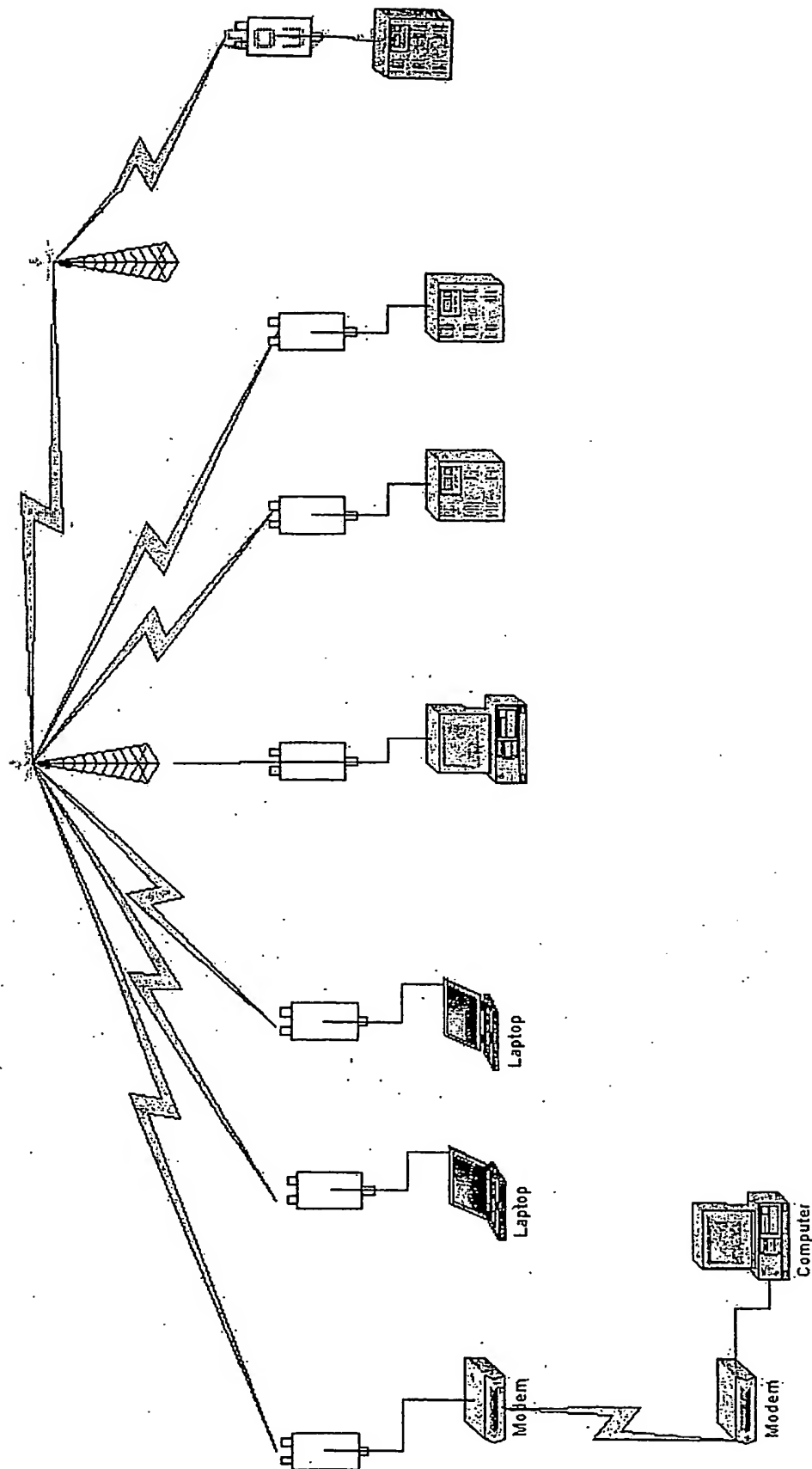
FIG. 1

FIG. 2
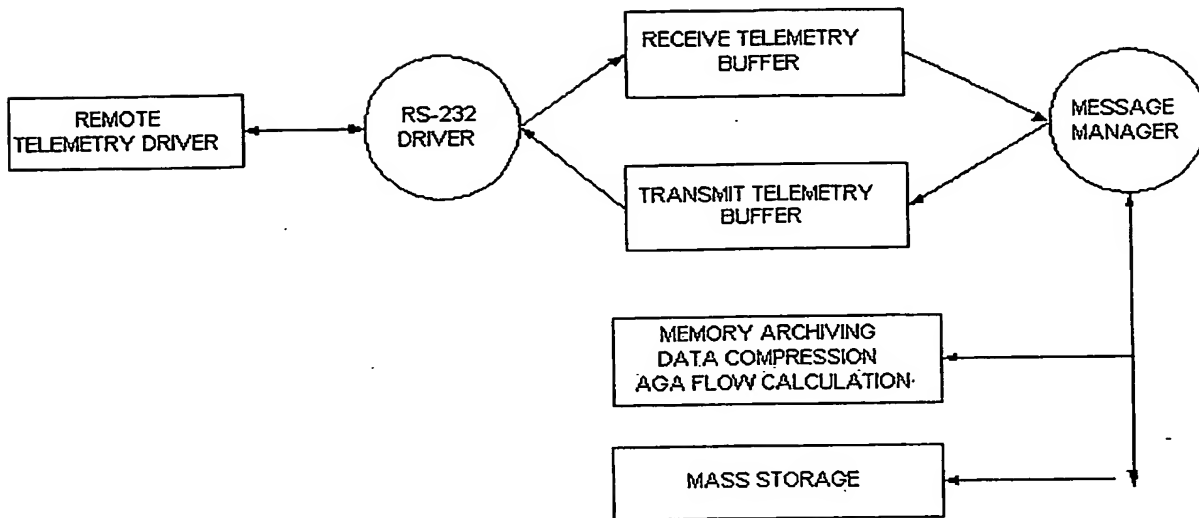
FIG. 3

HOST TELEMETRY DRIVER FLOW CHART

RECEIVE TELEMETRY BUFFER

REMOTE TELEMETRY DRIVER

RS-232 DRIVER

MESSAGE MANAGER

TRANSMIT TELEMETRY BUFFER

MEMORY ARCHIVING DATA COMPRESSION AGA FLOW CALCULATION·

MASS STORAGE

FIG. 4

REMOTE TERMINAL UNIT TELEMETRY DRIVER FLOW CHART

RECEIVE TELEMETRY BUFFER

HOST TELEMETRY DRIVER

RS-232 DRIVER

MESSAGE MANAGER

TRANSMIT TELEMETRY BUFFER

MEMORY ARCHIVING DATA COMPRESSION MANAGER

MASS STORAGE

FIG. 5